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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Attorney Docket No: 37697-0033

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Applicant(s):	Edward W. MERRILL *et al.*	Confirmation No.:	8881
Serial No.:	09/764,445	Examiner:	Duc Truong
Filing Date:	January 19, 2001	Group Art Unit:	1711

Title: RADIATION AND MELT TREATED ULTRA HIGH MOLECULAR WEIGHT POLYETHYLENE PROSTHETIC DEVICES

DECLARATION OF ORHUN K. MURATOGLU

I, Orhun K. Muratoglu, do hereby declare as follows:

1. I am the Deputy Director of Orthopedic Biomechanics and Biomaterials Laboratory at the Massachusetts General Hospital and a faculty member at Orthopedic Surgery Department of the Harvard Medical School.

2. I received my doctorate in 1995 from the Massachusetts Institute of Technology in Polymer Science and Technology. I have been engaged in the field of materials science for over a decade. A copy of my *curriculum vitae* is attached as Exhibit 1.

3. I have reviewed the captioned application and the office actions issued by the examiner, including the final office action dated July 08, 2003 (Paper No. 19). I provide this declaration with analysis and experimental evidence in support of the

Claim 128 is enabled by the captioned application

4. The examiner rejected claim 128[1] on enablement grounds. I am informed that the enablement requirement means that a specification must provide teachings that permit a person of skill in the art to make and use the invention without having to undertake undue experimentation. I am informed that undue experimentation would be manifest when efforts are required that are considered outside of or beyond the efforts normally expected in the field. Accordingly, routine design choices would not be considered undue experimentation, but the need to undertake comprehensive changes or extensive supplemental efforts to a disclosure would amount to undue experimentation. An extreme example of undue experimentation would be a specification that is so deficient that a person skilled in the art would have to undertake activities that amount to the act of invention itself to practice the claimed subject matter.

5. The captioned application discloses the starting materials and the production methodologies disclosed in U.S. Patent Nos. 6,017,975 (Saum '975 patent) and 6,242,507 (Saum '507 patent). Thus, the skilled artisan relying on the captioned application can produce the same cross-linked ultrahigh molecular weight polyethylene disclosed in the Saum '975 and '507 patents[2] and recited in claim 128 without the need for undue experimentation. All that claim 128 does is set forth some characterization data, and such data is just as dependent on the type of test run as it is on the nature of the composition itself.

6. In the instant situation, the product and its properties are inseparable, and different types of characterization data are a result of different types of tests being run, rather than differences in the tested composition. Thus, the data set forth in claim 128

[1] For ease of reference, the citations I provide are only to the Saum '975 patent

could be met by practice of an invention disclosed in the captioned application without having to undertake undue experimentation.

7. Claim 128 recites "A cross-linked ultrahigh molecular weight polyethylene having a swell ratio of less than about 5 and an oxidation level of less than about 0.2 carbonyl area/mil sample thickness after aging the ultrahigh molecular weight polyethylene at 70°C, for 14 days in oxygen at a pressure of about 5 atmospheres."

8. The following experiment was conducted to demonstrate that the captioned specification describes and enables the subject matter recited in claim 128. Ultrahigh Molecular Weight Polyethylene ("UHMWPE") was irradiated at 175°C to 100 kGy with an electron beam in a nitrogen atmosphere. These parameters are taught in captioned specification at page 19, lines 9-13 and page 30, lines 8-21, and original claims 83-86, and U.S. Patent No, 5,879,400 (issued from parent application U.S. application serial no. 08/600,744) at column 2, lines 45-47 and column 6, line 53 to column 7, line 15). Then, the irradiated UHMWPE was aged in an oxygen-containing pressure chamber at 70°C at 5 atm pressure for 2 weeks. Following aging, infrared analysis on the irradiated UHMWPE was performed and the oxidation levels were determined. Swell ratio testing also was performed per the Saum '975 patent (see column 7, lines 57-59).

9. This experiment provided the following data:

(a) The average maximum oxidation level, found in four irradiated UHMWPE specimens within the first 2 mm, was 0.1378 ± 0.0735 carbonyl area/mil.

(b) Swell ratio of four specimens was 3.31 ± 0.5.

6,017,975 (see column 7, lines 47-56) and U.S. Patent No. 6,242,507 (see column 8,

lines 8-18). In this vein, the Saum '975 patent references the Nagy and Li methods (see Saum '975 patent at column 7, lines 50-52), which discloses how to determine the oxidation level. The oxidation level was calculated as the integration of the carbonyl peak between limits of 1660 and 1800 per Nagy and Li and then normalized (that is, divided) that value to the thickness of the sample in mils.

11. As set forth above in paragraph 9, practice of the disclosed invention in the experiment yielded cross-linked ultrahigh molecular weight polyethylene according to claim 128 which exhibited a swell ratio of "less than about 5" and an oxidation level of "less than about 0.2 carbonyl area/mil" sample thickness after aging at 70°C for two weeks in oxygen at a pressure of about 5 atmospheres. Therefore, it is evident from the experimental findings that the subject matter recited in claim 128 can be obtained without the need for undue experimentations by the skilled person following the teachings of U.S. Serial Nos. 09/764,445, 08/726,313 and 08/600,744.

The captioned application enables packaging and sterilizing

12. The examiner rejected claims 124 and 130 for not enabling the non-irradiative sterilization and packaging of implants, although the examiner admitted that the application does enable formation of implants themselves.

13. Sterilization and packaging are common requirements in the area of UHMWPE medical implants, and have been practiced in the field for decades. Common approaches can be divided into two basic categories, namely irradiative and non-irradiative. Non-irradiative approaches have the advantage of not creating free radicals in the finished UHMWPE medical implant.

or steam. When using non-irradiative sterilization approaches, the implant is placed in

a permeable package that will allow the sterilizing gas, such as ethylene oxide or steam, to reach the implant while still separating the implant from the environment, where contamination would otherwise occur. This packaging and sterilization approach is schematically depicted in figures 1 and 2 of Lewis, *Medical Device Technology* 16-25 (January/February 1991) (Exhibit 2). These figures show that Et0 (ethylene oxide) or H_2O (heated to steam) permeates the package and displaces air such that the ethylene oxide or steam can sterilize the packaged implant. Accordingly, by 1991 the standard practice in the field was to place implants in air-permeable packaging and then sterilize them with a gas, such as ethylene oxide or steam.

15. The captioned application at page 11, lines 21-22 discloses the use of ethylene oxide and heat, which means the use of steam in the context of UHMWPE implants. Ethylene oxide and heat also are disclosed in parent application serial no. 08/726,313 at the bottom of page 8, and heat is disclosed in parent application 08/600,744 at page 8, lines 19-22. The Saum '975 patent at column 2, line 43 and column 6, lines 3-7 identifies ethylene oxide as a non-irradiative sterilization approach. Accordingly, the captioned application and its priority applications disclose non-irradiative sterilization approaches, such as ethylene oxide, which also are disclosed in the Saum '975 patent. The use of these gas-based approaches signifies the use of air-permeable packaging, as explained above in paragraph 14.

16. In sum, the skilled person relying on the captioned application would be able to employ non-irradiative sterilization with air-permeable packaging at least as early as the February 1996 priority date of the captioned application given that these methodologies were widely disseminated and practiced no later than 1991.

17. I understand that the examiner denied the captioned application the benefit of priority to earlier filed applications on the grounds that the applications "are based on similar but different specification with different goals." See page 2 of the final office action. I am informed that in order to claim a priority benefit to a previously filed patent application (a "priority application"), that patent application must enable practice of the claimed subject matter, and the test for enablement is set forth above in paragraph 4. I also am informed that a priority application must contain a written description of that subject matter. I am informed that the written description requirement means that a specification must contain sufficient disclosure to show that the inventors possessed the claimed invention.

18. Enabling written support for claim 128 and packaging/sterilizing is discussed above. Below I confirm the existence of enabling written description in the priority applications for all of the claims:

CLAIM	EXEMPLARY SUPPORT IN THE '744 APPLICATION
124. A process for preparing a medical implant having an improved balance of wear properties and oxidation resistance comprising the steps of:	Improved mechanical properties are disclosed at pages 10-11 and Tables 1-6. Medical implants are disclosed at page 1, lines 3-5 and original claims 1-12. Oxidation resistance is discussed at page 3, lines 6-7, and page 23, lines 16-17.
irradiating a perform of ultrahigh molecular weight polyethylene to form free radicals;	Types of polyethylene, including ultrahigh molecular weight

	radicals is a natural consequence of irradiation and results in the creation of cross-links upon recombination. See page 10, lines 14-15; page 13, line 20 to page 14, line 6; page 14, line 26 to page 15, line 5.
annealing the irradiated preform by heating in a substantially oxygen-free atmosphere at a temperature above about 150°C, for a time sufficient to recombine substantially all of the free radicals and cross-link the ultrahigh molecular weight polyethylene;	Temperatures above the melting point, including those above 150°C, are disclosed at page 4, lines 10-11; page 13, lines 14-15 and Example 3. The use of a low oxygen-containing nitrogen atmosphere in Example 3. Recombination of free radicals is discussed at page 23, lines 7-17 and original claim 2.
cooling the cross-linked preform while maintaining a substantially oxygen-free atmosphere;	Cooling in a nitrogen atmosphere is disclosed at page 25, lines 2-6. Cooling also is discussed at page 14, lines 10-15.
forming a medical implant from the cross-linked preform;	Medical implants formed from the cross-linked polyethylene disclosed at page 2, lines 6-10 and Examples 3 and 6.
packaging the medical implant in an air-permeable package; and	Packaging is a known requirement of medical implants to protect them from

sterilizing the packaged implant using non-irradiative methods.	Sterilization, such as by heat (steam), is a known requirement for medical implants. See page 8, lines 19-22.
125. A process for preparing a medical implant having an improved balance of wear properties and oxidation resistance comprising the steps of:	Improved mechanical properties are disclosed at pages 10-11 and Tables 1-6. Medical implants are disclosed at page 1, lines 3-5 and original claims 1-12. Oxidation resistance is discussed at page 3, lines 6-7, and page 23, lines 16-17.
irradiating a preform of ultrahigh molecular weight polyethylene to form free radicals;	Types of polyethylene, including ultrahigh molecular weight polyethylene, are disclosed at page 16, lines 4-7. Irradiation is disclosed at page 13, line 22. Formation of free radicals is a natural consequence of irradiation and results in the creation of cross-links upon recombination. See page 10, lines 14-15; page 13, line 20 to page 14, line 6; page 14, line 26 to page 15, line 5.
annealing the irradiated preform by heating in a substantially oxygen-free atmosphere at a temperature above about 150°C, to cross-link the ultrahigh molecular weight polyethylene;	Temperatures above the melting point, including those above 150°C, are disclosed at page 4, lines 10-11; page 13, lines 14-15 and Example 3.

	Cross-links are discussed at page 13, lines 28-29 and page 14, line 5.
cooling the cross-linked preform while maintaining a substantially oxygen-free atmosphere;	Cooling in a nitrogen atmosphere is disclosed at page 25, lines 2-6. Cooling also is discussed at page 14, lines 10-15.
forming a medical implant from the cross-linked preform.	Medical implants formed from the cross-linked polyethylene disclosed at page 2, lines 6-10 and Examples 3 and 6.
126. A medical implant prepared according to the process of claim 124.	See discussion for claim 124.
127. A medical implant prepared according to the process of claim 125.	See discussion for claim 125.
128. A cross-linked ultrahigh molecular weight polyethylene having a swell ratio of less than about 5 and an oxidation level of less than about 0.2 carbonyl area/mil sample thickness after aging the ultrahigh molecular weight polyethylene at 70°C, for 14 days in oxygen at a pressure of about 5 atmospheres.	Improved mechanical properties are disclosed at pages 10-11 and Tables 1-6. Swell ratios that are less than 5 are disclosed at Tables 2 and 6. Minimized oxidation is discussed at page 10, last paragraph and page 22. Cross-links are discussed at page 13, lines 28-29 and page 14, line 5. Types of polyethylene, including ultrahigh molecular weight

	above the melting point are disclosed at page 4, lines 10-11; page 13, lines 14-15 and Example 3. Cooling in a nitrogen atmosphere is disclosed at page 25, lines 2-6. Cooling also is discussed at page 14, lines 10-15. It is the above starting materials and production steps that result in the cross-linked ultrahigh molecular weight polyethylene. See paragraphs 7-11 above.
129. A medical implant comprising the ultrahigh molecular weight polyethylene of claim 128.	See claim 128 above. Medical implants made from cross-linked ultrahigh molecular weight polyethylene having improved mechanical properties are disclosed at page 1, lines 3-5 and original claims 1-12.
130. A process for preparing a medical implant having an improved balance of wear properties and oxidation resistance comprising the steps of:	Improved mechanical properties are disclosed at pages 10-11 and Tables 1-6. Oxidation resistance is discussed at page 3, lines 6-7, and page 23, lines 16-17.
irradiating a preform of ultrahigh molecular weight polyethylene to form free radicals;	Preforms are discussed at the paragraph bridging pages 11 and 12 and Examples 3 and 6. Types of

	disclosed at page 16, lines 4-7. Irradiation is disclosed at page 13, line 22. Temperatures above the melting point are disclosed at page 4, lines 10-11; page 13, lines 14-15 and Example 3. Formation of free radicals is a natural consequence of irradiation and results in the creation of cross-links upon recombination. See page 10, lines 14-15; page 13, line 20 to page 14, line 6; page 14, line 26 to page 15, line 5.
annealing the irradiated preform by heating at a temperature above about 150°C, for a time sufficient to recombine substantially all of the free radicals and cross-link the ultrahigh molecular weight polyethylene;	Temperatures above the melting point, including those above 150°C, are disclosed at page 4, lines 10-11; page 13, lines 14-15 and Example 3. Recombination of free radicals is discussed at page 23, lines 7-17 and original claim 2.
cooling the cross-linked preform;	Cooling is discussed at page 14, lines 10-15 and page 25, lines 2-6.
forming a medical implant from the cross-linked preform;	Medical implants formed from the cross-linked polyethylene disclosed at page 2, lines 6-10 and Examples 3 and 6.

packaging the medical implant in an air-permeable package; and	Packaging is a known requirement of medical implants to protect them from the environment. See Exhibit 2.
sterilizing the packaged implant using non-irradiative methods.	Sterilization, such as by heat (steam), is a known requirement for medical implants. See page 8, lines 19-22.
143. A process for preparing a medical implant having improved mechanical properties, wherein the method comprises:	Improved mechanical properties are disclosed at pages 10-11 and Tables 1-6.
irradiating a polyethylene article to form free radicals; and	Types of polyethylene, including ultrahigh molecular weight polyethylene, are disclosed at page 16, lines 4-7. Irradiation is disclosed at page 13, line 22. Polyethylene articles are disclosed at the paragraph bridging pages 11 and 12 and Examples 3 and 6.
heating the polyethylene article to a temperature at or above the melting point such that the free radicals can recombine.	Temperatures above the melting point are disclosed at page 4, lines 10-11; page 13, lines 14-15 and Example 3. Recombination of free radicals is discussed at page 23, lines 7-17 and original claim 2.

the '744 application, meaning that the '744 application shows possession of the claimed

invention and enables the skilled person to make and use the claimed invention without having to resort to undue experimentation. Therefore, the application is entitled to a priority date of February 13, 1996.

19. The claims also are supported by U.S. application serial no. 08/726,313, filed October 2, 1996, which incorporates by reference the '744 application. I identify exemplary support below:

CLAIM	EXEMPLARY SUPPORT IN THE '313 APPLICATION
124. A process for preparing a medical implant having an improved balance of wear properties and oxidation resistance comprising the steps of:	Improved mechanical properties are disclosed at pages 10,11, 19 and 42-43; and Tables 1-6. Medical implants are disclosed at page 1, lines 12-15 and original claims 1-12, and methods of making are disclosed in Examples 1-8. Oxidation resistance is discussed at page 3, lines 13-16 and pages 41-42.
irradiating a perform of ultrahigh molecular weight polyethylene to form free radicals;	Types of polyethylene, including ultrahigh molecular weight polyethylene, are disclosed at page 24, lines 13-19. Preforms are

	paragraph; and Examples 2, 3 and 6. Irradiation is disclosed at page 13, and page 22, lines 13-14. Formation of free radicals is a natural consequence of irradiation and results in the creation of cross-links upon recombination. See page 9, lines 9-26; page 12, lines 15-21.
annealing the irradiated preform by heating in a substantially oxygen-free atmosphere at a temperature above about 150°C, for a time sufficient to recombine substantially all of the free radicals and cross-link the ultrahigh molecular weight polyethylene;	Temperatures above the melting point, including those above 150°C, are disclosed at page 14, lines 2-7, and page 21, first full paragraph. The use of a low oxygen-containing nitrogen atmosphere in Example 3. Recombination of free radicals is discussed at page 14. The use of other gases and a vacuum are disclosed at page 14 and Example 13.
cooling the cross-linked preform while maintaining a substantially oxygen-free atmosphere;	Cooling in a nitrogen atmosphere is disclosed at page 25, lines 21-24. Cooling also is discussed at page 12, lines 21-24 and page 22, lines 22-28.
forming a medical implant from the cross-linked preform;	Medical implants formed from the cross-linked polyethylene disclosed at Examples 3 and 6.

packaging the medical implant in an air-permeable package; and	Packaging is a known requirement of medical implants to protect them from the environment. See Exhibit 2.
sterilizing the packaged implant using non-irradiative methods.	Sterilization is a known requirement for medical implants. See page 8, last paragraph, disclosing the use of ethylene oxide and heat (steam).
125. A process for preparing a medical implant having an improved balance of wear properties and oxidation resistance comprising the steps of:	Improved mechanical properties are disclosed at pages 10,11, 19 and 42-43; and Tables 1-6. Medical implants are disclosed at page 1, lines 12-15 and original claims 1-12, and methods of making are disclosed in Examples 1-8. Oxidation resistance is discussed at page 3, lines 13-16 and pages 41-42.
irradiating a preform of ultrahigh molecular weight polyethylene to form free radicals;	Types of polyethylene, including ultrahigh molecular weight polyethylene, are disclosed at page 24, lines 13-19. Preforms are disclosed at page 11, second full paragraph; page 12, first full paragraph; and Examples 2, 3 and 6. Irradiation is disclosed at page 13, and page 22, lines 13-14. Formation

	in the creation of cross-links upon recombination. See page 9, lines 9-26; page 12, lines 15-21.
annealing the irradiated preform by heating in a substantially oxygen-free atmosphere at a temperature above about 150°C, to cross-link the ultrahigh molecular weight polyethylene;	Temperatures above the melting point, including those above 150°C, are disclosed at page 14, lines 2-7, and page 21, first full paragraph. The use of a low oxygen-containing nitrogen atmosphere in Example 3. Recombination of free radicals is discussed at page 14. The use of other gases and a vacuum are disclosed at page 14 and Example 13.
cooling the cross-linked preform while maintaining a substantially oxygen-free atmosphere;	Cooling in a nitrogen atmosphere is disclosed at page 25, lines 21-24. Cooling also is discussed at page 12, lines 21-24 and page 22, lines 22-28.
forming a medical implant from the cross-linked preform.	Medical implants formed from the cross-linked polyethylene disclosed at Examples 3 and 6.
126. A medical implant prepared according to the process of claim 124.	See discussion for claim 124.
127. A medical implant prepared according to the process of claim 125.	See discussion for claim 125.

than about 5 and an oxidation level of less than about 0.2 carbonyl area/mil sample thickness after aging the ultrahigh molecular weight polyethylene at 70°C, for 14 days in oxygen at a pressure of about 5 atmospheres.	43; Tables 1-6 and Examples 4 and 5. Oxidation resistance is discussed at page 3, lines 13-16 and Example 11. Swell ratios are disclosed at pages 45-46. See paragraphs 7-11 above.
129. A medical implant comprising the ultrahigh molecular weight polyethylene of claim 128.	Medical implants formed from the cross-linked polyethylene disclosed at Examples 3 and 6. See also the discussion for claim 128.
130. A process for preparing a medical implant having an improved balance of wear properties and oxidation resistance comprising the steps of:	Improved mechanical properties are disclosed at pages 10,11, 19 and 42-43; and Tables 1-6. Medical implants are disclosed at page 1, lines 12-15 and original claims 1-12, and methods of making are disclosed in Examples 1-8. Oxidation resistance is discussed at page 3, lines 13-16 and pages 41-42.
irradiating a preform of ultrahigh molecular weight polyethylene to form free radicals;	Types of polyethylene, including ultrahigh molecular weight polyethylene, are disclosed at page 24, lines 13-19. Preforms are disclosed at page 11, second full paragraph; page 12, first full paragraph; and Examples 2, 3 and 6. Irradiation is disclosed at page 13

	consequence of irradiation and results in the creation of cross-links upon recombination. See page 9, lines 9-26; page 12, lines 15-21.
annealing the irradiated preform by heating at a temperature above about 150°C, for a time sufficient to recombine substantially all of the free radicals and cross-link the ultrahigh molecular weight polyethylene;	Temperatures above the melting point, including those above 150°C, are disclosed at page 14, lines 2-7, and page 21, first full paragraph. The use of a low oxygen-containing nitrogen atmosphere in Example 3. Recombination of free radicals is discussed at page 14. The use of other gases and a vacuum are disclosed at page 14 and Example 13.
cooling the cross-linked preform;	Cooling is discussed at page 12, lines 21-24, page 22, lines 22-28 and page 25, lines 21-24.
forming a medical implant from the cross-linked preform;	Medical implants formed from the cross-linked polyethylene disclosed at Examples 3 and 6.
packaging the medical implant in an air-permeable package; and	Packaging is a known requirement of medical implants to protect them from the environment. See Exhibit 2.
sterilizing the packaged implant using non-	Sterilization is a known requirement

	ethylene oxide and heat (steam).
143. A process for preparing a medical implant having improved mechanical properties, wherein the method comprises:	Improved mechanical properties are disclosed at pages 10,11, 19 and 42-43; and Tables 1-6. Medical implants are disclosed at page 1, lines 12-15 and original claims 1-12, and methods of making are disclosed in Example 1-8. Oxidation resistance is discussed at page 3, lines 13-16 and pages 41-42.
irradiating a polyethylene article to form free radicals; and	Types of polyethylene, including ultrahigh molecular weight polyethylene, are disclosed at page 24, lines 13-19. Polyethylene articles are disclosed at page 11, second full paragraph; page 12, first full paragraph; and Examples 2, 3 and 6. Irradiation is disclosed at page 13., and page 22, lines 13-14. Formation of free radicals is a natural consequence of irradiation and results in the creation of cross-links upon recombination. See page 9, lines 9-26; page 12, lines 15-21. Articles are disclosed at page 11, first full paragraph and page 12, lines 6-9.

heating the polyethylene article to a temperature at or above the melting point such that the free radicals can recombine.	Temperatures above the melting point, including those above 150°C, are disclosed at page 14, lines 2-7, and page 21, first full paragraph. Recombination of free radicals is discussed at page 14.

As shown above, each of the pending claims find enabling written description in the '313 application, meaning that the '313 application shows possession of the claimed invention and enables the skilled person to make and use the claimed invention without having to resort to undue experimentation. Therefore, the application also is entitled to a priority date of October 2, 1996.

*****

I hereby declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further, that these statements are made with the knowledge that willful false statements, and the like so made, are punishable by fine or imprisonment, or both, under Section 1001, Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

10/6/03
Date

Orhun K. Muratoglu

Exhibit 1

Curriculum vitae of Orhun K. Muratoglu

DATE PREPARED: Friday, October 3, 2003

Name: Orhun Kamil Muratoglu, Ph.D.

Office Address: Massachusetts General Hospital
Orthopaedic Biomechanics Laboratory
GRJ 1206
Boston, MA 02114

Home Address: 5 Dana Street
Cambridge, MA 02138

E-Mail: orhun *@* alum.mit.edu
FAX: (617) 726 3883

Place of Birth: Erzurum, Turkey

Education:

1991 B.S. Rensselaer Polytechnic Institute, Materials Science and Engineering

1995 Ph.D. Massachusetts Institute of Technology, Materials Science and Engineering, Program in Polymer Science and Technology

Academic Appointments:

1995-2002	Instructor, Harvard Medical School, Orthopaedic Surgery
2000-present	Alan Gerry Scholar, Massachusetts General Hospital, Orthopaedic Surgery
2002-present	Assistant Professor, Harvard Medical School, Orthopaedic Surgery

Hospital or Affiliated Institution Appointments:

1995-2001 Assistant Bioengineer, Massachusetts General Hospital, Orthopaedic Surgery

1995-present Research Affiliate, Massachusetts Institute of Technology, Department of Chemical Engineering

2001-present Deputy Director, Orthopaedic Biomechanics and Biomaterials Laboratory, Massachusetts General Hospital

1999-present Visiting Clinician, Shriners Hospital for Children, Boston

1995-present	American Institute of Chemical Engineers, Member
1995-present	Society for Biomaterials, Member
1996-present	American Society for Testing and Materials
1997-present	Orthopaedic Research Society, Member
2000-present	American Academy of Orthopedic Surgeons

Awards and Honors:

1989-1991 Dean's List, 4 of 4 semesters at Rensselaer Polytechnic Institute
1990-1991 Matthew Albert Hunter Prize for outstanding academic achievement at Rensselaer Polytechnic Institute
1991 Rensselaer Polytechnic Institute, Summa Cum Laude
1991-1992 PPST Fellowship sponsored by Shell and Mobil at Massachusetts Institute of Technology
1992-1994 DuPont Fellowship at Massachusetts Institute of Technology
1995 First prize, Hoechst Celanese Polymer Poster Competition at Massachusetts Institute of Technology
1995 Massachusetts Institute of Technology, Summa Cum Laude
1998 Best Paper Award Montreal RETEC '97, Society of Plastics Engineers, Inc., "Mechanisms of Deformation and Toughness in Rubber-Modified Semicrystalline Thermoplastics"
1999 'HAP' Paul Award International Society for Technology in Arthroplasty 1999 Meeting, "A Novel Method of Crosslinking UHMWPE to Improve Wear, Reduce Oxidation and Retain Mechanical Properties"
2000 2000 Partners In Excellence Award for excellence in leadership, innovation, and teamwork.
2001 Marshall R. Urist Young Investigator Award for 2001, "A Highly Crosslinked, Melted UHMWPE: Expanded Potential for Total Joint Arthroplasty"

Invited Presentations:

Invited Lectures, Massachusetts Institute of Technology, Summer Professional Course on 'Toughening of Polymers: Mechanistic Principles, Experiments and Modeling,' Boston, Massachusetts, 1995

Invited Lecture, Workshop on Polyethylene, Combined Orthopaedic Research Society, San Diego, California, 1995

Plenary Lecture, 1998 Gordon Conference on Tribology, New Hampshire, 1998

Invited Lecture, Material Science and Engineering Colloquium Series, Ohio State University, Ohio, 1998

Invited Lecture, Mechanical Engineering, Aeronautical Engineering and Mechanics, Rensselaer Polytechnic Institute, Albany, New York, 1999

Invited Lecture, European Knee Osteoarthritis Week, Arthroplasty Symposium, Ulm Germany, 2000

Grand Rounds, Carney Hospital, Dorchester, Massachusetts, 2000

Invited Lecture, 2nd Harlaching Spring Symposium, Munich, Germany, 2000

Invited Lecture, Whistler 2000 Orthopaedic Symposium, Whistler, British Columbia, Canada, 2000

Invited Lecture, Orthopaedic Research Society, Wear 2000 Workshop, Orlando, Florida, 2000

Invited Lecture, 2000 Hip, Knee and Shoulder Symposium, Park City, Utah, 2000

Invited Lecture, American Academy of Orthopaedic Surgeons and National Institute of Health (AAOS NIH), Wear 2000 Workshop, Oak Brook, Illinois, 2000

Invited Lecture, Italian Society of Orthopedics and Traumotology, 85th National Congress, Torino, Italy, 2000

Invited Lecture, The 27th Annual Meeting of the Japanese Hip Society, Nagoya, Japan, 2000

Invited Lecture, Triennial Congress of the Asian Pacific Orthopaedic Association, Adelaide, South Australia, April 1-6, 2001

Invited Lecture, Workshop on Ultra-High Molecular Weight Polyethylene, Society for Biomaterials, 27th Annual Meeting, St. Paul Minnesota, April 24, 2001.

Invited Lecture, New Test Methods for Evaluating the Performance of Conventional and Crosslinked UHMWPE at the American Society for Testing and Materials, Quantification of Radiation Dose for UHMWPE, Phoenix, AZ, May 8, 2001.

Invited Lecture, Der Osteoblast 2001, Osteologie in Forschung und Praxis, Wurzburg, Germany, November 17, 2001.

Invited Keynote Lecture, Tribology Issues in Biology and Medicine, Argonne National Laboratory, Argonne, Illinois, December 10-12, 2001.

Grand Rounds, University of Utah, University Hospital, Salt Lake City, Utah, January 16, 2001.

Invited Lectures, The 2002 Hip, Knee, and Shoulder Symposium, Park City, Utah, March 6-10, 2002.

Invited Lecture, The Third Annual Turkish Arthroplasty Meeting, Antalya, Turkey, September 16, 2002.

Grand Rounds, University of Oklahoma College of Medicine, Department of

2002

Invited Lectures, 2003 Hip, Knee and Shoulder Symposium, Park City, Utah, 2003.

Invited Lecture, 2003 European Orthopaedic Research Society Satellite Symposium, Helsinki, Finland. June 4-7, 2003.

Invited Lecture, 2003 European Federation of National Associations of Orthopaedic and Traumatology, Helsinki, Finland, June 4-10, 2003.

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Original Articles:

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